U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS.

IN COOPERATION WITH THE MICHIGAN AGRICULTURAL EXPERIMENT STATION.

RECONNAISSANCE SOIL SURVEY OF ONTONAGON COUNTY, MICHIGAN.

BY

O. VEATCH, IN CHARGE, AND JAMES TYSON, OF THE MICHIGAN AGRICULTURAL EXPERIMENT STATION, AND W. D. LEE, OF THE U. S. DEPARTMENT OF AGRICULTURE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1921.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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Soil map, Ontonagon County sheet, Michigan.

RECONNAISSANCE SOIL SURVEY OF ONTONAGON COUNTY, MICHIGAN.

By J. O. VEATCH, in Charge, and JAMES TYSON, of the Michigan Agricultural Experiment Station, and W. D. LEE, of the United States Department of Agriculture.

DESCRIPTION OF THE AREA.

Location.—Ontonagon County is situated in the northern peninsula of Michigan, in the northwestern part, which fronts on Lake Superior. It has a land area of 1,314 square miles, or 840,960 acres.

Topography.—The topography of the county is largely a product of glaciation. While the higher relief of the old land surface was but thinly covered and remains in part to lend physiognomic character and diversity, the preglacial topography throughout the greater part of the county was completely obscured by glacial deposition during the Pleistocene period. The general effect of continental glaciation in the northern United States has been to produce a flattened surface or softened topography. Locally in the glaciated region there may be a diversity of features, but without any great range in altitude or notable relief.

FIG. 5.—Sketch map showing location of the Ontonagon County area, Michigan.

The topography in this particular area comprises constructional forms of glacial origin—level plains, hills, ridges, and basins—which have not been appreciably altered by erosion since their formation, together with features of the old topography standing out in bolder relief, such as the Porcupine Mountains and the Copper Range.

Four fairly well defined physiographic divisions occur within the area: (1) Level plains representing the beds of old glacial lakes; (2) a hilly division in the southeastern part of the county; (3) a narrow range of low knobs and ridges across the central part of the county; (4) the Porcupine Mountains in the northwestern part of the county.

The lake-bed plains comprise the greater part of the area. Lying back, or southward, from the present shore line of Lake Superior four old shore lines have been distinguished in the study of the geology of this region.[1] Each marks a stage in level of a vast sheet of water,

[1] Leverett, Frank. The Surface Formations of Michigan. Pub. 25, Mich. Geol. Survey, 1917.

formed during the glacial period, as it diminished in area to the present Lake Superior. The highest stage is represented by an old shore line some 25 to 30 miles inland and a lake-bed plain approximately 700 feet above Lake Superior. The other three stages are represented by plains successively lower in elevation. In places there is a well-marked escarpment or rise from one plain to the next higher, but the casual observer passing across the county from north to south would likely be unaware of the existence of separate plains and be conscious only of a gradual increase in elevation. The range in elevation above sea level is from approximately 600 feet on the shore of Lake Superior to 1,300 or 1,400 feet in the extreme southern part of the county.

The surface of the plains is in general nearly level. Streams have cut shallow trenches, but owing to the short time they have existed they have developed few tributaries, and as a consequence the only steep slopes or broken lands are restricted to narrow strips along the courses of the larger rivers.

On the narrow lowermost plain fronting Lake Superior the surface is hummocky or uneven for a distance of a few hundred yards inland from the present beach. Here the old beach sand occurs in ridges, probably without much change, as originally formed by action of waves and wind.

The division of rolling and hilly topography in the southeastern part of the county comprises an area of about 100 square miles. This region is a moraine characterized by low ridges with smooth or rounded slopes, hummocks, and sharp knobs, with an uneven sky line, all without any systematic arrangement. Dry, flat-bottomed, filled-in valleys and also basins containing lakes and swampy tracts are characteristic. The topography is typically morainic. The tops of the hills and ridges probably do not rise more than 100 or 150 feet above the level of the valleys, except in a few places. To the west of this hilly division, on the west side of Ontonagon River, in T. 46 N., R. 40 W., the land is more level, although underlain by morainal débris. The maximum elevation in this division is about 1,600 feet above sea level.

The central range of rock knobs has a general northeast-southwest trend and extends entirely across the central part of the county. It marks the southwestern extension of the Copper Range of the Keweenawan Peninsula. The range on the whole does not rise to any great height above the plains, although many of the rock masses exhibit bold slopes, 100 to 300 or 400 feet high, facing the south or southwest. These knobs must have been the higher outstanding features of the old preglacial topography in this part of the county. Their tops are but thinly covered, while the valleys between them are filled to comparatively great depths by glacial débris, so that the range is not continuous or unbroken, but consists of a succession of separate knobs or small table-lands projecting above the level sheets of glacial débris and lake-bed deposits. The general elevation of the knobs is 1,200 to 1,400 feet above sea level.

The Porcupine Mountains are located in the northwestern part of the county and consist of high, roughly parallel ridges separated by valleys filled in deeply with glacial débris. The northernmost ridge

is about 6 miles long, has an east-west direction, and rises 1,000 to 1,200 feet above Lake Superior within distances of 1 to 2 miles back from the shore. The south side of this ridge is characterized by a steep slope and in places by barren rock cliffs. A broad and comparatively smooth valley, 1 to 3 miles wide, occupied by Carp River and Carp Lake, separates this ridge from a parallel ridge of rock knobs, one of which reaches an elevation of 2,022 feet,[2] the highest elevation in the northern peninsula of Michigan. Other ridges and detached knobs, rising a few hundred feet above the plains, lie a few miles to the southwest of the main ridges and are properly included as a part of the Porcupine Mountains.

In addition to these four major divisions, there is in the extreme southwestern part of the county, west of Lake Gogebic, a level till plain, in large part swamp, which comprises several square miles, and which, although small in extent, genetically constitutes a separate physiographic division.

Over the greater part of the county the slope of land is sufficient to carry off excess rainfall or else there is free subsurface drainage. Swamps and bogs are widely distributed, but only a few separate tracts comprise as much as 1 to 2 square miles. The total area of swamp land is about 27,000 acres, which probably constitutes a smaller percentage than in any other county in the northern peninsula.

There are comparatively few lakes for a glaciated country, not more than a dozen in the county of any considerable size, although there must have been many more originally, as there is abundant evidence that many of the swamps and bogs represent lakes filled by vegetation. The one large inland lake is Lake Gogebic, in the southwestern part of the county, which has an area of a little more than 20 square miles.

All of the larger streams and most of the creeks and branches are perennial. The general direction of stream flow is northward, and the drainage of the whole area eventually reaches Lake Superior. The principal streams are the Ontonagon River and its several branches.

Water supply.—An abundant supply of good water can be obtained from wells at shallow depths, except in places on the rock knobs and those localities in the south-central part of the county where the clay is uniform and of great thickness in the lake-bed plains.

Vegetation.—The whole region was originally in dense forest, and a few great tracts of virgin forest still remain. Several types of forest, or associations of trees, are represented: (1) The hardwood or deciduous forest, in which the dominant species are hard maple and yellow birch, with smaller proportions of basswood, ash, and elm; (2) the mixed hardwood and coniferous forests, consisting of the common hardwoods associated with an equal or slightly greater quantity of hemlock, white pine, spruce, and fir; (3) the white-pine forest, including some Norway pine and jack pine; (4) the hemlock forest; (5) the swamp forest, in which the common species are arbor vitæ, white spruce, black spruce, tamarack, fir, and white pine. The hardwood and mixed conifer-hardwood types comprise the greater acreage and volume of growth. On the dry land the forest, being

[2] Determination of elevation by United States Lake Survey.

dense, inhibits the growth of very much shrubby or herbaceous undergrowth, and further the accumulation of a thick layer of dry peaty mold is also unfavorable for such growth. However, on lands which have been logged over and have been repeatedly swept by fire, herbaceous vegetation, including grasses of pasturage value, appears, and is followed later by a dense second growth consisting mainly of aspen or "popple."

Transportation facilities.—Transportation facilities are afforded by the Duluth, South Shore & Atlantic Railway, which passes east and west across the southern part of the county, and by a branch of the Chicago, Milwaukee & St. Paul Railway, which passes through the northeastern part of the county and terminates at Ontonagon. Ontonagon and Houghton (Houghton County) are connected by the Chicago, Milwaukee & St. Paul and the Copper Range Railroads. A branch of the Chicago & North Western Railway enters the southern part of the county.

Main highways, which are parts of a State and county system of roads, connect the principal towns of the county. These are graded and macadamized roads which are maintained in good condition for automobile and wagon traffic. However, over the greater part of the county there is as yet only a comparatively small mileage of improved roads, so that large tracts of country remain difficultly accessible.

Markets.—The agricultural products at present are mainly sold locally and in near-by cities and mining towns of the northern peninsula. The distance and cost of transportation to the larger city markets are at present among the factors that retard agricultural development.

Settlement and population.—The first white settlers came to this region about 1843, mostly to engage in mining and fur trading. Ontonagon was one of the first six counties into which the northern peninsula was divided by act of legislature in 1843. Ontonagon, with a population of 1,406, is the county seat.

The population has remained sparse and has been governed by the development of lumbering and mining and the need for labor in these industries. The present population (1920 census) is 12,428, equivalent to a density of 9.3 persons per square mile. A large part of the population is foreign born, or consists of children of foreign-born parents, principally Finns, Poles, Austrians, and peoples from other European countries and from Canada. A considerable number of the foreign born, particularly the Finns, in recent years have begun clearing land and establishing farms.

CLIMATE.

The northern peninsula lies mainly between parallels 45° and 48° north latitude. The features of the climate are a mean temperature of about 37° F., a normal precipitation (including melted snow) of about 32 inches, a snowfall of more than 100 inches, low humidity, low percentage of sunshine, low wind movement, and low evaporation.

The winters are of long duration and frequently extremely rigorous, as normally the mean temperature is below freezing from November

to March, and a minimum of −48° F. has been recorded. The period of warm weather is correspondingly short and is characterized by a moderate temperature with a seasonal average, June to August, of about 63° F.

Variations in temperature and time of frosts are marked enough in different parts of the county to have a good deal of significance in relation to agriculture. It appears that the first killing frosts may be as much as one month later in the fall along the shore of Lake Superior than on the higher lands, back some 10 to 20 miles. The country fronting the lake, therefore, has a material advantage for the growing of fruit and other crops that are late in maturing. The period between killing frosts in the spring and autumn is about 140 days along the shore of Lake Superior, assuming that conditions here are about the same as at Marquette and Houghton, while on the higher plain or table-land in the central and southern parts of the county it may be only 80 or 90 days. It appears, however, that on this higher land the heat of summer may be a little greater, which would compensate in part for the shorter growing season. Light frosts damaging to the more tender vegetation may occur even in July and August. Possibly the longer period of daylight in this region as compared with regions farther south compensates to some extent for the shortness of the growing season as measured in number of days.

The precipitation is fairly evenly distributed throughout the year, but consists of 2 to 3 inches more during the fall than during either the spring or summer. Owing to low humidity and low evaporation (probably about 30 inches from a free water surface) the precipitation appears to be ample for the production of staple crops. The rainfall varies from year to year, and short periods of drought occur, but crop failures can not be attributed to deficiency in moisture, except on some of the most pervious and nonretentive soils. Precipitation for the most part falls as slow rains and rarely as destructive downpours, thus enabling the soils to absorb a greater proportion of the rainfall.

Snowfall forms a permanent cover for periods of 5 or 6 months, from about November to April, and prevents the freezing of the soil to great depths and protects grain planted in the fall.

The prevailing winds are westerly. The wind movement is generally low, but at times attains high velocity on the lake shore.

The following tables, showing the more important climatic data, are compiled from records of the United States Weather Bureau. In the absence of complete records in this county for a long period of years, the table for Houghton, in Houghton County, is given as representing climatic conditions near the lake shore, and the table for Thomaston, in Gogebic County, is given as representing climatic conditions in the higher section farther from the lake.

Normal monthly, seasonal, and annual temperature and precipitation at Houghton, Houghton County.

(Elevation, 668 feet.)

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1903).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	16.8	57	−16	2.47	1.93	4.06	27.5
January	13.4	50	−31	2.04	2.67	2.54	26.4
February	9.3	54	−27	1.78	1.00	1.74	17.4
Winter	13.1	57	−31	6.29	5.60	8.34	71.3
March	19.4	78	−22	2.10	3.10	3.27	15.3
April	36.8	88	− 1	2.03	1.01	3.70	8.9
May	48.6	92	22	3.29	1.39	4.85	.9
Spring	34.9	92	−22	7.42	5.50	11.82	25.1
June	58.4	101	34	3.49	4.32	.60	.0
July	62.2	103	41	3.10	4.54	4.66	.0
August	60.0	95	37	2.87	2.60	2.03	.0
Summer	60.3	101	41	9.46	11.46	7.29	.0
September	53.7	94	31	3.54	2.00	3.03	T.
October	43.0	87	18	3.18	2.40	3.52	1.9
November	28.4	67	3	2.80	2.65	5.17	18.4
Fall	41.7	94	3	9.52	7.05	11.72	20.3
Year	37.5	101	−31	32.69	29.61	39.17	116.7

Normal monthly, seasonal, and annual temperature and precipitation at Thomaston, Gogebic County.

(Elevation, 1,347 feet.)

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1897).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	14.8	48	−24	2.47	2.43	1.51	18.5
January	12.4	50	−42	2.04	1.80	4.40	20.1
February	9.5	50	−46	1.71	.00	2.32	12.1
Winter	12.2	50	−46	6.22	4.23	8.23	50.7
March	22.7	78	−31	2.10	1.15	2.41	14.9
April	37.9	90	−10	2.03	.51	1.44	8.5
May	50.8	92	10	3.29	1.01	3.98	.7
Spring	37.1	92	−31	7.42	2.67	7.83	24.1
June	60.7	96	22	3.49	2.24	4.40	.0
July	64.7	101	28	3.10	3.10	9.40	.0
August	62.8	98	29	2.87	.60	1.60	.0
Summer	62.7	101	22	9.46	5.94	15.40	.0
September	53.4	95	16	3.54	2.03	2.84	.2
October	44.5	82	4	2.18	.80	1.78	1.5
November	29.1	68	−11	2.80	.60	2.36	12.8
Fall	42.3	95	−11	9.52	3.43	6.98	14.5
Year	38.6	101	−46	32.62	16.27	38.44	89.3

AGRICULTURE.

Agriculture has been carried on in this region in a very small way since its early settlement by white men. The first cultivation of the soil was attempted because of pressing need of fresh vegetables and other products for individual use, and subsequently it was found to be profitable within the scope of supplying the mines, logging camps, and lumber mills with food products and hay and feed for work animals. In historical accounts mention is made of farming as early as 1857 and of a county fair being held in 1868 at which wheat, rye, barley, beans, peas, apples, and garden vegetables were exhibited.[3] The census of 1880 shows that oats, wheat, rye, hay, potatoes, and corn occupied a total of 2,073 acres in 1879. Farming has continued up to the present, but with only a very slow increase in the number of farms and area of land cleared. The census of 1920 shows a total of 22,341 acres for all crops in 1919, exclusive of a small acreage in orchards. The entire acreage in crops is less than 3 per cent of the total area of the county. Only 9.4 per cent of the county is included in farms, and of the land in farms 31.2 per cent, or 25,025 acres, is reported by the census as improved land. About half of this improved land has been cleared for farming in the last 10 years.

Agriculture has remained unimportant as an industry in comparison with lumbering and mining, because these other industries have offered greater immediate returns on the labor and investment involved. Lands have not been rapidly utilized after lumbering because in the past agriculture here could not successfully compete with that on land equally cheap and of equal or greater productiveness in other parts of the United States, much of which required no initial expense for clearing. However, as practically all of the public land in the West suitable for farming has been occupied and as cheap lands are no longer available in the agricultural sections of the Middle West and West, attention must be turned toward the development of the relatively cheap cut-over lands as the need for additional farms or increased agricultural production arises.

The principal agricultural development in this county to date has been directly along the line of the Duluth, South Shore & Atlantic Railway in the southern part, adjacent to the towns of Ewen, Bruce Crossing, Matchwood, and Trout Creek. Considerable land has also been cleared in patches for several miles out from Ontonagon, and there are a number of farms in the immediate vicinity of the mining towns of Rockland, Greenland, and Mass. But in the western, central, and northeastern parts extensive tracts of virgin forest still remain, and whole townships may be found in which no agricultural development at all has been undertaken.

The principal crops grown in the county at the present time, in order of their acreage, are hay (mostly red clover and timothy), oats, wheat, potatoes, barley, field peas, and rye. Other crops occupying only a very small acreage or grown in a more or less experimental way include rutabagas, buckwheat, corn, sunflowers, and alfalfa. The orchard fruits are mainly apples, but plums and cherries also produce in favorable years. Raspberries grow wild, and the small patches of strawberries which have thus far been set out have pro-

[3] Michigan Historical Magazine, Vol. V, January-April, 1921, p. 118.

duced well. Many of the common garden vegetables, such as cabbage, onions, lettuce, and squash, are grown with some degree of success. But the growing season is comparatively short, frosts sometimes occurring during the summer months, and the variety of crops grown is not as wide, and the yields are not as dependable, as in the southern part of the State.

Red or June clover and alsike clover are grown, with little or no difficulty in obtaining a good stand. This is particularly true on newly cleared land and on the heavier types of soil. Clover and mixtures of timothy and clover constitute the most valuable crops produced at present, as the hay is the principal winter feed for dairy and farm stock and usually commands a fair price locally. The average yields are about 1½ tons per acre; generally only one cutting per year can be obtained. In 1919 tame grasses were cut for hay on 14,826 acres, with a yield of 19,739 tons.

Oats are a reasonably sure crop on all types of soil. According to the census, the average yield is approximately 25 bushels per acre. However, higher yields are produced on the heavier soils and under favorable conditions, and yields of 50 to 60 bushels per acre have been reported.

Wheat, according to the census, occupied 1,608 acres in 1919 and gave an average yield of approximately 10 bushels per acre. Winter wheat may be planted with probabilities for success as good as for spring wheat, as a heavy covering of snow can be depended upon. On the clay and silt types of soil the yields are somewhat higher than the average. Farmers in the vicinity of Bruce Crossing and Ewen have reported yields as high as 30 to 40 bushels per acre, but probably these yields should be regarded as exceptional.

Barley and rye have been grown only in small patches, the barley mainly for the grain, which is used to feed cattle and sheep, and the rye mainly for pasture.

Potatoes of excellent quality can be grown and fair yields are obtained. The census reports 876 acres in potatoes in 1919, with an average yield of approximately 90 bushels per acre. Potatoes may be regarded as a fairly dependable cash crop, particularly on the lighter soils.

Corn is grown in small patches of 1 to 6 or 8 acres for dry forage and for silage. The varieties of Dent corn which thus far have been grown have failed to mature grain.

Rutabagas are not grown extensively, but seem to give fair yields, and therefore offer possibilities because of their value as feed for sheep and cattle.

Dairying has already become an industry of some local importance. Creameries and small cheese factories have been established in nearly all of the towns and villages, and in 1919 the value of all dairy products was reported as amounting to $218,924. The herds kept are mainly mixed grades in which Holstein blood predominates.

Only a small number of beef cattle and hogs are raised or fattened, and these mainly to supply the purely local demand for meat. Several farmers own small herds of sheep. Cut-over forest lands which have been burned over frequently since logging and which are not covered too densely by aspen or other second growth of trees and shrubs, or by ferns, afford good pasture for sheep and cattle. In addition to native forage plants, clover and timothy are growing

wild or can be easily introduced by seeding without preparation of the soil. The virgin forests afford little or no grazing.

Commercial fertilizers have not yet been used in any considerable quantity. Apparently the surface soil, especially those virgin soils from which thick coverings of forest mold have been burned in land clearing, are well supplied with available plant food, but it seems improbable that high productiveness can be maintained for any great period of time, especially on the lighter soils, without the use of fertilizers and some system of maintaining the supply of organic matter in the soil.

No common system of crop rotation or generally adopted procedure in handling the soils has been developed from experience, as in other regions where agriculture has been carried on extensively for a long period of time. However, the value and necessity of changing crops, as opposed to continuous cropping on the same piece of land, is generally recognized, and some kind of rotation, even if it is not always uniform or systematic, is followed where hay, grain, and root crops or potatoes are grown. It is generally considered the best practice to plow land, particularly the heavy types of soil, in the fall rather than in the spring, as the soil is very likely to be excessively wet in the spring and a good tilth difficult to obtain.

The farms are generally small, containing, with few exceptions, not more than 40 or 80 acres, and with about one-third or less of each farm actually under cultivation. The low acreage per farm under cultivation is attributed more to the high cost of clearing land than to any other factor. The great bulk of the land is still owned in large tracts by a comparatively few individuals and by lumber and mining companies.

The price of unimproved land, which embraces cut-over forest land, with stumps and more or less second growth and unmerchantable standing timber, ranges at present (1921) from $10 to $40 an acre, depending upon a number of factors, such as location, the cut-over condition, the terms of sale, and to some extent the agricultural value. In some instances lands have been offered for sale at low prices on a plan whereby the purchaser is relieved of payment until after the lapse of a certain number of years. Improved land, which is completely cleared of stumps and roots, is held at $100 or more an acre.

Judging from present experience in northern Michigan and similar areas in Wisconsin, under the natural and economic conditions prevailing, a type of dairy farming in conjunction with the growing of hay and small grains will probably prove most successful in this region, particularly on the heavier types of soil. On certain of the lighter types it is probable that a diversity of crops, including potatoes, root crops, garden vegetables, and fruit, can be grown with some degree of success, although on these soils dairying or the raising and fattening of sheep and cattle will probably also be found most profitable in the end. Farming on the newly settled land has not yet reached a stage of development where it affords an independent living for the worker, and probably the greater number of occupants of such farms under present conditions are forced to seek outside labor in logging camps, mines, or on the highways to supplement the farm income. The present hindrances—high cost of clearing land, lack of good local markets, and high cost of transportation to outside markets—will doubtless be overcome or obviated in the future as

more economical methods of clearing, better farm methods, and varieties of crops adapted to the soil and climate are worked out and discovered.

Probably the chief factor retarding agricultural development at present is the cost of clearing land. The cost may be expected to vary greatly, depending upon such factors as the type of soil, moisture conditions, kind, number, and age of stumps, methods employed, and cost of labor.

A classification of land according to use or value for agriculture and according to grade or quality, while always open to the objection that it lacks permanence because it can be based only on existing economic conditions and upon present knowledge and standards of value and is never entirely satisfactory to all interests concerned, nevertheless may serve a useful purpose. Even if it goes no further than to determine approximately the relative areas of entirely nonarable land and that of least value for farming purposes, it should be of assistance to the State or National Government in framing policies and to individuals in arriving at conclusions as to the possibilities for agriculture in regions in which the soil resources have remained undeveloped. The following tentative classification is based on intrinsic peculiarities of the soil, topography, drainage, comparative stoniness, together with conclusions drawn from the experience of farmers in this and the similar region of Wisconsin:

Classification of land in Ontonagon County, Mich.

Grade.	Soil types.	Approximate area.[1]
		Square miles.
Class A, arable lands. Soil character and results of experience indicate that farming may be carried on with some assurance of moderate success at present or in the near future.	Mainly Ontonagon clay, Ontonagon silt loam, Ontonagon fine sandy loam, and other undescribed types.	660
Class B, lands of low or moderate fertility, in part stony and otherwise unfavorable, but on which some farming is carried on and which must be regarded as arable and potential agricultural land.	Mainly Porcupine loam, Roselawn stony sandy loam, Bergland clay, Ewen fine sandy loam, Rubicon sand, and Ontonagon silt loam, stony phase.	450
Class C, including entirely nonarable land, that requiring greatest expense for reclamation, and that of lowest productiveness.	Mainly the rougher land of rock knobs, swamp (Peat and Muck soils), and coarsest and most droughty soils.	200

[1] In the absence of a more detailed survey areas given can be only approximate, and also since they are based upon existing general economic conditions are subject to change.

It is evident that there is a very great acreage of arable land having a potential value for agriculture, but it does not follow that immediate extensive development for farming of all of this, nor even all of it of the first class, is justified or would be profitable under existing economic conditions. But all of the land is capable of producing crops of trees, and it is therefore no more than a commonsense proposal, from the point of view of public policy, to advocate its use for forestry until such time as there is need for it to increase agricultural production or until the social welfare demands its use to supply additional farm homes.

SOILS.

The soils of Ontonagon County may be grouped under two heads—well-drained soils and poorly drained soils. The well-drained soils may be grouped into those with well-developed or what may be called normal soil profiles or sections and those with imperfectly developed or incomplete soil sections.

The soils with good drainage and mature profiles may be grouped into smaller units to any desired degree of refinement, according to the purpose which the grouping is expected to serve. The subdivisions which serve as types or units of mapping in a soil survey are based on intrinsic properties of soils, such as their texture, structure, and chemical composition. A great number of divisions are possible, according to variations in these features in different parts of the soil profile and variations in the thickness of the different soil layers.

In virgin or forested areas the generalized section or profile of the well-drained soils with well-developed profiles is about as follows: (1) Organic layer of litter, mold, and humus soil; (2) gray layer of mineral soil; (3) brown layer of mineral soil, the color largely derived from organic matter; (4) mineral soil free from organic matter, but showing evidence of surface weathering; this layer is generally thin; (5) geologic substratum.

This generalized profile is present, regardless of moderate variations in slope, and is independent of the geologic formation from which the soil has been derived. The distinguishing characteristics of the profile are the relatively great thickness and undecomposed condition of the plant remains in layer No. 1, while the humus soil portion of this layer comprises only a very thin section of one-half to 2 inches just beneath the layer of plant remains; the gray layer, which contains but very little organic matter, and is more completely leached of basic elements and coloring from red iron oxide than the lower horizons; and the brown layer, No. 3, which is present either as a well-defined separate layer or is represented by coloration or staining at the top of layer No. 4. The soils of this group are generally leached of calcium carbonate in the surface layer and most of them are acid to depths of 10 to 36 inches, including layer No. 3, and in places part or all of layer No. 4. The thickness of the soil above the geologic substratum is generally 3 to 5 feet.

In the Ontonagon area the surface geologic formations are deposits of glacial origin, comprising several kinds, according to origin and topographic expression, such as moraines, till plains, sand and gravel plains of aqueoglacial origin, and deposits in old glacial lakes.[4]

Soil types and geologic divisions do not coincide closely in this region, for the obvious reason that the peculiarities of the soil profile which distinguish types are derived only in part from the underlying geologic formation. Relation to the texture of types may be very close or nonexistent, according as the degree of refinement in making geologic subdivisions on a purely lithologic basis is as great as that in making soil types.

Soil-forming processes have been active in this region since the close of the Wisconsin stage of glaciation. Geologically this is a

[4] A most complete study of the glacial geology of the Northern peninsula, which includes also an application of the geologic studies to agriculture, has been made by Frank Leverett, in Publication No. 25, Michigan Geological Survey, 1917.

relatively short time. However, the thickness of the soil layer, which is equivalent to the surface zone of weathering, is 3 to 5 feet. The rather extraordinary thickness of this zone, considering age, is accounted for by the fact that the geologic deposits were unconsolidated and already in a comminuted and more or less decomposed state when the soil-forming processes began to operate immediately after the final retreat of the ice sheet.

For the purposes of mapping soils, according to the system used in this survey, the soils are classified into soil series on the basis of common characteristics of color and structure and common origin, and the series are divided into types on the basis of difference in texture of the surface layer of mineral soil.

The soils that would be included in the group of soils with fair to good drainage and mature profile have been classed in the present survey in the Ontonagon, Roselawn, Porcupine, and Rubicon series.

The types of the Ontonagon series are characterized by a relatively retentive clayey subsurface layer at shallow depths. This may occur at depths of a few inches to as much as 3 to 4 feet, but at either depth it has an influence on the moisture content and in other ways directly or indirectly influences plant growth. The deeper subsurface layers and the substratum have a reddish color, Indian red or brick red when moist, and the inference is that a comparatively high percentage of ferric hydrate is present. This coloration has been inherited largely from the parent rock and is not entirely the result of weathering since glacial times. Appreciable percentages of calcium carbonate are present and an alkaline reaction is shown in the red clay at shallow depths. Three types of the Ontonagon series are mapped in this county—the fine sandy loam, silt loam, and clay. It is possible that in some places the surface layer of the fine sandy loam is of different geologic origin or represents a deposition separate from that of the clay type.

The Roselawn series is characterized by a pervious structure throughout the whole depth of the soil. There was originally no strong reddish coloration from the parent rock, and what there was has been removed from the weathered layer to a depth of 3 to 5 feet. The soils are in an acid condition, and the unweathered material below is noncalcareous to a depth of several feet. One type, the stony sandy loam, is mapped.

The soils of the Porcupine series are moderately pervious and penetrable throughout, owing to an admixture of stones and gravel, although the mineral base is loamy or contains considerable silt and clay. As with the Ontonagon series, the lower subsoil and substratum have a strong reddish color. The gray and brown layers of the profile are less conspicuously developed than in the Roselawn series.

The Rubicon series is characterized by a conspicuously developed brown or tan-colored layer of sand at depths of 6 inches to 2 feet, which in places is more or less cemented and has the nature of a hardpan. The structure both above and below the brown layer is loose and pervious. That above the brown layer is gray sand, with a thin veneer of dark loamy sand at the surface, and that below is a yellowish or grayish sand or sand and gravel. None of the red rock coloration, so conspicuous in the Ontonagon and Porcupine series, occurs within the profile of this series.

Those soils with imperfectly developed sections are for the most part recent alluvium. The soil material is practically equivalent to a geologic formation, since the textural and structural variations are those of the fluvial deposit, which has undergone very little change, even at the surface, by soil-forming processes since it was laid down. The greater part of the alluvium in this county is sandy and loose in structure near the surface, with a coarser and more pervious substratum at shallow depths. This kind of soil has been classified in the Ewen series. In places some of the alluvium is characterized by a darker surface soil of more compact structure and silt or clay texture, but this was not mapped separately in the present survey.

Narrow strips of beach sand and wind-blown deposits along the shore of Lake Superior should be regarded as belonging to this group of young soils, but these strips are so negligible in area that it is not worth while to outline them on the map in a reconnaissance survey of this nature.

The soils developed under deficient drainage and excessive moisture conditions have the following generalized profile: (1) Organic layer in the nature of peat or muck; (2) grayish or drab transitional layer of plastic mineral soil; (3) geologic substratum of sand, clay, or gravel.

A number of subdivisions in this group are possible on the basis of differences in thickness of the organic layer and in the physical and chemical nature of the different layers, as in the case of mineral soils, and according to the nature of the substratum where the cumulose deposit is relatively shallow. The transitional layer of mineral soil has a light color, probably owing to lack of aeration and reduction of ferric iron; and a sticky or slimy character is developed to a greater degree than in material of similar texture in the well-drained mineral soils. In the present survey most of the soils of this group are described as Peat and Muck, without differentiation as to depth of the organic layer, character of underlying material, or stage of decomposition, because of the impracticability of making a detailed survey at the present time.

One series of minor importance, which is related to this group, is intermediate between this and the group of well-drained mineral soils. This is the Bergland series, characterized by a thin, mucky surface layer, a gray, highly plastic clayey layer, and a reddish, compact clay substratum.

In a virgin region where the native vegetation remains undisturbed, or where it is a simple matter to determine its composition in recently cut-over areas, the plants present in associations, and to a less extent single species, rightly interpreted, are an expression of soil conditions and therefore may indicate the worth of land for agricultural purposes. The native vegetation may serve as a convenient, although temporary, basis of classification, particularly because it affords more tangible criteria than do intrinsic soil characteristics. However, it must be borne in mind that observed relations between native vegetation and agricultural value as a rule are purely local in their application. Since this is an undeveloped region, the observation of relations between the native vegetation and the soil in this county is particularly applicable.

On the sand soils, which are well drained, loose, and pervious in structure and underlain by a coarse, pervious substratum, and there-

fore low in the absolute content of moisture, the dominant tree is, or was originally, white pine. On the deepest sands Norway pine (*Pinus resinosa*) and jack pine (*P. divaricata*) are components of the forest growth along with the white pine, and where the first two species are abundant the soil is likely to be lowest in productiveness. On old cut-over areas of such soils bracken and sweet fern form a dense ground cover, and white birch and large-toothed aspen appear to be more abundant in the growth succeeding lumbering than elsewhere.

White pine also appears as the most abundant species on level lands where the soil is heavy and is underlain at shallow depths by compact clay, which is relatively impervious and difficultly penetrable by roots of trees. In places, as near Matchwood, white pine existed in nearly pure stands on such soil (Ontonagon clay). A suggested explanation of its occurrence on such sites is that there is actually as little water available for the trees here as on the sands, since the clay is very compact and roots can penetrate only to shallow depths, and therefore conditions are unfavorable for broad-leaved species, which require greater supplies of moisture for growth.

Generally where this clay type of soil predominates the forest growth is characterized by an association of white pine, balsam (*Abies balsamea*), and white spruce (*Picea canadensis*), with scattering hardwoods. Aspen or "popple" forms an unusually dense cover on this type of land soon after logging.

An association of hardwoods, mainly hard maple and yellow birch, with less basswood and elm, generally denotes a well-drained, loamy, deep, and penetrable soil, and naturally the most fertile. However, such land may be excessively stony and too steeply sloping to be of value for cultivated field crops.

Where hemlock is dominant or comprises a large proportion of the forest in association with hardwoods, the soil was observed to be generally sandy and intermediate in texture and structure, moisture content, and fertility between the pure hardwood lands on the one hand and the white pine-jack pine lands on the other.

A mixed hardwood-conifer forest; that is, where the two are about in equal proportions, with hard maple, yellow birch, hemlock, white spruce, fir, and arbor vitæ as the principal species, was found growing on types of soil which it is believed have a high potential agricultural value.

The drier peaty soils of the swamps are characterized by a growth of arbor vitæ, white spruce, and a few scattered white pine. Wetter soils support black spruce and tamarack, along with willows, alder, cassandra, and blueberry. Still wetter situations and open bogs are characterized by sedges and other herbaceous aquatic vegetation. In this latitude this class of soils is believed to have the lowest agricultural value.

It is believed that all of the soil types in Ontonagon County that occupy any considerable aggregate area, and are, therefore, of importance in an inventory of soil resources, have been differentiated. These are described briefly in the following pages, but not all of them have been delineated on the soil map. The greater part of the county is either in the condition of cut-over land or in virgin forest which is so difficult to traverse as to render the making of a very detailed soil map impracticable on account of the time and labor involved. The map accompanying this report, therefore, is in the nature of a

reconnaissance, in which only the major types are mapped. It should serve, however, as a basis for a preliminary classification of the lands according to use or relative agricultural value, and, properly interpreted, it should be of assistance to the prospective farmer in deciding upon the most desirable location under present conditions and to the owners of large tracts in selecting for sale the lands upon which farming is most likely to succeed.

As agricultural development proceeds, farming becomes more specialized and intensive, and the demand for the less valuable lands arises, greater detail in classification and location of soil boundaries will be justified.

The table below shows the actual and relative extent of the several types mapped. Each separate color on the map represents simply the dominant soil type, so that a number of other types, some of which may be quite different in agricultural value, may be included. The actual area of organic (Peat and Muck) soil is certainly greater than is indicated by the map, and the percentage of the various textural classes of sands and sandy loams as shown by the table is probably too low, as considerable acreages of these lighter soils have been included with the Ontonagon clay and silt loam types.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Ontonagon silt loam	229,952	29.2	Ontonagon fine sandy loam	27,136	3.2
Stony phase	15,808		Peat and Muck	18,176	2.1
Ontonagon clay	186,432	22.2	Ewen fine sandy loam	17,536	2.1
Porcupine loam	154,560	18.4	Bergland clay	3,136	.4
Rubicon sand	67,072	8.0	Coastal beach	576	.1
Rough stony land	61,120	7.3			
Roselawn stony sandy loam	59,456	7.0	Total	840,960	

ONTONAGON FINE SANDY LOAM.

The profile of the virgin soil of the Ontonagon fine sandy loam consists of (1) a surface layer of forest mold and humus 2 to 4 inches; (2) a layer of grayish or faded red mineral soil, a loamy fine sand to fine sandy loam in texture, extending to a depth of 8 to 10 inches; (3) a reddish-brown or cinnamon-colored fine sandy loam, the color of which is due in part to organic matter, to a depth of 24 to 30 inches; (4) reddish clay loam or silty clay loam, which may extend to great depth with little change in texture, or give way to reddish clay at varying depths below 36 inches. The cultivated soil, in which the organic layer and the bleached gray material have become mixed, is grayish brown in color.

The third horizon in places has a slightly compact or hardpanlike character, owing presumably to organic matter, but possibly also to iron oxide or other colloidal substances. Calcium carbonate and other soluble basic compounds appear to have been largely leached out to depths of as much as 3 to 4 feet, as the soil gives an acid reaction to these depths. This type is more friable, penetrable, and pervious than the clay and silt loam types of the Ontonagon series. A comparatively retentive and less pervious layer or substratum at depths of not more than 4 to 5 feet is the chief basis of distinction

between this and the Rubicon sand type. This is probably a material factor in determining the amount of moisture held within reach of plant roots.

This type is rather widely distributed, but much of it occurs in small bodies not easily separated from other types, and has not been outlined in detail on the soil map. The largest areas are in the northern part of the county, one lying in a narrow strip between Ontonagon and the Porcupine Mountains and another in the northeastern corner.

Most of the land is nearly level, but generally has sufficient slope to provide drainage adequate for farming, especially as the structure of the surface soil is open and pervious.

The forest growth is, or was originally, of the mixed hardwood-conifer type, in which hemlock apparently is the dominant species. There is a scattering growth of white pine, which attains large size.

This type of soil is under cultivation on several small farms. Potatoes, clover hay, oats, rye, rutabagas, common garden vegetables, apples, and small fruits have been grown. The areas in which sandy clay or a well-developed brown layer occurs at depths of not more than 3 or 4 feet will probably prove to be the more productive land. This type should have some advantages over the clay and silt loam types of soil, in that it is more easily tilled, warms up a little earlier, and is better adapted to root crops and fruit.

ONTONAGON SILT LOAM.

The profile of the virgin soil of the Ontonagon silt loam consists of (1) a layer of forest mold and humus soil 2 to 4 inches deep; (2) a light-grayish silt loam, floury or ashy when dry, to a depth of 8 to 15 inches; (3) a brownish or cinnamon-colored silt loam, which derives its coloring from organic colloids, to depths of 18 to 24 inches; (4) a reddish compact silty or fine sandy clay loam of 36 to 40 inches; and (5) a substratum of reddish silty or fine sandy clay to depths of 10 feet or more. Under cultivation the soil to a depth of 6 to 8 inches is a brownish-gray to brown silt loam.

The layer of gray soil and the brownish layer are thicker and more conspicuously developed than the corresponding layers in the Ontonagon clay type. Layer No. 4, or the lower subsoil, is a slightly darker shade of red than the substratum but is not sharply separated from it. This type contains a higher percentage of silt and fine sand in the soil, subsoil, and substratum than does the clay type, so that it permits freer percolation of water, freer aeration, and root development to a greater depth.

At 15 to 24 inches the material is moderatly compact and retentive but not impervious or impenetrable to roots. The first layer, the organic soil, loses its identity after the soil is cultivated. In the virgin soil this layer is acid, but becomes neutral or alkaline after burning; the gray layer is acid, the upper subsoil or the brown layer is highly acid; and the material from about 24 to 30 inches is slightly acid or neutral. The substratum contains appreciable amounts of calcium carbonate.

This is the principal type of soil in a belt of country about 8 to 10 miles wide in the northern part of the county, lying back one-fourth

mile to 2 miles from the Lake Superior shore, east of the Porcupine Mountains.

This area is a nearly level or gently rolling plain, trenched to shallow depths by northward-flowing streams. The slope of the land is nearly everywhere sufficient to insure drainage adequate for farming. The elevation ranges from about 700 feet near Lake Superior to possibly 1,000 to 1,200 feet in the areas farthest south.

The forest growth is the mixed hardwood-conifer type. The slight dominance of one or the other group of trees appears to bear a relation to slight variations in the texture of the soil and to drainage and moisture conditions. The principal hardwoods are hard maple, yellow birch, and basswood, with fewer trees of ash, elm, and ironwood. The principal conifer is hemlock, with fewer arbor vitæ, white spruce, and white pine trees. The tree growth is so dense as practically to inhibit herbaceous or shrubby undergrowth. Because of the dense growth the slashings present an almost hopeless tangle, so far as clearing operations are concerned, immediately after the land is cut over. After repeated burnings a large number of stumps remain, and clearing for cultivation involves a great amount of labor, time, or heavy expense.

On the land that has been placed under cultivation, which lies mainly to the east of Ontonagon, the following crops have been grown in a small way with variable success: Hay (alsike or red clover and timothy), potatoes, wheat, oats, rye, buckwheat, rutabagas, corn for silage, sunflowers, alfalfa, apples, and a few of the common garden vegetables. The present indications are that hay is likely to be the most dependable crop and dairying the most successful agricultural industry. The soil should also prove especially well suited to the production of potatoes. The texture and other physical properties of the soil compare favorably with those of the Caribou soils in northern Maine, where the potato industry has been so highly developed.

Land that has been cleared completely of stumps and roots and leveled off presents no especial difficulties in tillage, and so far as inferences can be drawn from the known physical and chemical properties and the results of experience in farming, it should be classed with the best soils in the county in agricultural value.

A soil occurring in association with the Ontonagon silt loam and fine sandy loam and the Rubicon sand was not mapped on account of its scattering distribution in small areas, but was included with the associated soils. This included soil has the peculiarities of profile common to the group of soils developed under conditions of good drainage. It is similar to the Ontonagon fine sandy loam and silt loam types, but differs from these in texture, since it is composed dominantly of very fine sand. The substratum is less clayey, but still moderately compact, as it is composed of silt or fine sand or alternate layers of these.

It is probable that this type comprises only a small aggregate area, which is in separate tracts closely associated with bodies of Ontonagon silt loam and fine sandy loam and Rubicon sand. It was observed in T. 53 N., R. 37 W., in the eastern part of the county, on the sloping benches between the Porcupine Mountains and the shore of Lake Superior, in the northwestern part of the county, and in the Iron River country southwest of the old Nonesuch mine. Because of the difficulties of accurately locating boundaries and

making consistent separations, no attempt has been made to outline the type on the accompanying soil map.

The land is level or gently sloping. The dense forest growth is mainly of the conifer type, in which various hardwoods are interspersed. Hemlock is the dominant species, and in places grows in almost pure stand; white pines, which are interspersed throughout the forests, were noted as attaining larger growth than on other soil types.

None of this land was seen under cultivation. On the basis of inferences which may be drawn from physical characteristics and the native vegetation, it would be expected to have considerable agricultural value under present conditions. Tillage should present fewer difficulties than on the clay type of soil, and moisture conditions would be expected to be fully as favorable as on the clay.

Ontonagon silt loam, stony phase.—The profile of the Ontonagon silt loam, stony phase, is very similar to that of the silt loam type, but the phase is distinguished from the typical soil by its stony character and slightly higher percentage of sand and gravel, which produces a somewhat more penetrable and pervious structure.

This soil occurs chiefly in small bodies in association with the Ontonagon clay in the vicinity of Trout Creek, Bruce Crossing, and Ewen. It occurs on ridges or low, broad hills in the lake-bed plains, or simply as stony land having no marked topographic expression. None of the land is excessively rough or too steeply sloping to be used for agriculture.

The forest growth is of the mixed hardwood-conifer type. The most abundant species appear to be hard maple, birch, and hemlock. There is a dense growth of trees, and consequently a large number of stumps per acre remain after lumbering.

In a few places the land has been cleared and apparently produces as good a growth of clover and other crops as the typical silt loam and clay types. The necessity of removing scattered stones adds somewhat to the cost of placing the land in condition for farming.

ONTONAGON CLAY.

The profile of the virgin soil of the Ontonagon clay under forest consists of (1) an organic layer of litter and forest mold, 2 or 3 inches thick, grading into a layer of dark-gray humus soil about 1 inch in thickness and ranging in texture from a silt loam to silty clay loam; (2) a light-gray or faded-red, friable silt loam to silty clay loam to 5 or 6 inches; (3) a reddish, fine-grained, impervious clay exhibiting a faint brownish coloration or mottled condition at the top, to a depth of 24 to 30 inches; (4) a light-red clay substratum. The clay is compact in structure, relatively impervious, and difficult to penetrate; it is highly retentive, but it is probable that a very high percentage of the water held is unavailable for plant use; it is strongly adhesive when wet to saturation and becomes extremely hard or very tough upon drying. Beginning at 20 to 30 inches, which appears to be the depth to which soil-forming agencies have acted, as indicated by a slightly different shade of red color and the presence of appreciable amounts of calcium carbonate, the substratum is compact and faintly laminated. This deposit extends to a depth of

many feet, possibly reaching a maximum thickness of as much as 200 feet, with very little sand interbedded.

The distinguishing peculiarities of the type are the thinness or almost entire absence of the gray layer, the thinness or absence of a brown subsurface layer, and the extremely high percentage (51.1 per cent) of clay in the subsoil, as shown by mechanical analysis, indicating a high colloid content. The gray layer apparently is leached of its soluble basic compounds to the extent that it shows an acid reaction when tested with a neutral indicator (bromo-thymol-blue); the clay at a depth of 6 to 8 inches is neutral or slightly alkaline; and the substratum beginning at depths of 24 to 30 inches is alkaline and at about 3 feet generally contains macroscopic accretions of calcium carbonate. The surface organic layer is acid in the virgin soil but does not appear to be so on cleared land, which may be explained by the presence of salts from ashes resulting from burning in clearing operations. The organic layer of the virgin soil is largely consumed in clearing, and under cultivation the red clay is turned up in plowing and mingled with the gray, more loamy, and less clayey soil of the surface layers, producing a light-brown or reddish silty clay loam soil 5 to 7 inches deep.

The Ontonagon clay is one of the more extensive types and occupies approximately 22 per cent of the total area of the county. It occurs mostly in one great body in the central and southern parts of the county.

Some of the land is nearly level or flat, but most of it is gently rolling or is characterized by long, gradual slopes and broad swells, and therefore has sufficient slope to carry off the excess rainfall. In places the land is strongly sloping and even deeply dissected, as in some of the country to the west of Rubicon in T. 50 N., R. 38 W., and elsewhere along the larger branches of the Ontonagon River. In general, however, in almost any land section the topography will allow the laying out of unbroken quadrangular fields of 40 acres or more, and the use of power implements is practicable.

The original forest growth was dense and consisted mainly of white pine, with variable percentages of hardwoods, spruce, and balsam fir. Where the soil is characterized by greater thickness of the gray layer and a coarser texture, there was more hardwood, and on the less well drained land and darker soil there was a higher percentage of white pine, spruce, and fir.

On most of the cut-over land it is chiefly the white-pine stumps that remain. The roots are not deeply embedded, but the stumps have a large diameter at the base and have long lateral roots. The growth that appears a few years after logging, unless kept down by fires, is chiefly aspen, with more or less fir and spruce, which forms a dense cover. The cost of dynamiting stumps, removing roots, leveling the land, and breaking for the first crop may reach as much as $100 or more an acre under present conditions. By slower methods the money cost may not be excessive, as where the stumps are pulled by horsepower and the labor is performed entirely by the owner of the land, but by this method only a few acres a year can be put in shape for cultivation.

Fair pasturage is afforded by land which has been kept clear of too dense a growth of trees following logging, as, in addition to native

grasses, clover and timothy spreads from old logging camps or can be seeded in stump land without cultivation of the soil.

The greater part of the cultivated land in the county at present is on this type of soil in the southern part of the county along the Duluth, South Shore & Atlantic Railway. Hay, composed of clover and timothy, is the most valuable crop, but oats, wheat, barley, and rye are also grown with a fair degree of success. Potatoes and root crops probably will not give as good results, except at much greater cost of production, as on the lighter soils. Fruit could hardly be expected to produce as well as on lands nearer the shore of Lake Superior, where the frost-free season is considerably longer. Dairying probably offers greater opportunities for profit than any other type of farming. A few of the settlers have small herds of sheep and cattle, which are maintained on the pasture afforded by the stump land, supplemented by the pasture on the cultivated land and by winter feeding.

The soil requires tractors or heavy teams for deep breaking, because of its dense clayey nature. It is reported that the soil bakes and forms into extremely hard clods if plowed when too wet. It is obvious, therefore, that fall plowing would be advantageous, as the clods or coarse lumps are broken down by weathering through the winter and early spring. Under certain conditions of tilth, rolling would probably be necessary in order to obtain a good seed bed. The application of manure or the turning under of green crops will maintain a good supply of humus and better tilth and will increase productiveness.

ROSELAWN STONY SANDY LOAM.

The profile of the virgin soil of the Roselawn stony sandy loam consists of (1) a layer of litter and forest mold, 2 to 4 inches; (2) humus soil, a dark-grayish loose loamy mixture of sand and humified organic matter 1 to 2 inches; (3) a light-grayish layer of sandy loam or medium sand, loose in structure, 4 to 8 inches; (4) a brownish or dark yellowish brown sandy loam, in which the color is due in part to organic matter, 6 to 10 inches; (5) sand or sandy loam changing from yellowish to grayish or pinkish, 2 to 8 inches; (6) a substratum which is a heterogeneous deposit of sand, clay, gravel, and scattered bowlders, in which the finer material is grayish with a pinkish tinge. In cultivated fields the surface soil to a depth of 6 to 8 inches is a brownish-gray fine to medium sandy loam.

A distinguishing peculiarity of this type is a loose, moderately pervious structure throughout the whole depth, although the content of silt and clay in the soil is appreciable. The brownish layer which forms the upper subsoil is not at all or only slightly coherent or cemented, and hence probably does not materially retard the percolation of water or retain any greater amount than the soil above or below it. Calcium carbonate, and probably also other basic compounds, appear to be pretty well leached out to depths of 2 to 3 feet or more, or are present in less quantities than in the substratum. However, on newly cleared land which has been frequently burned over the soil to a depth of 2 to 8 inches gives a neutral or alkaline reaction.

The substratum is lithologically complex and consists of a mixture of a great variety of crystalline rocks, both basic and acidic, and some shale, sandstone, or slate of local origin.

Stones are scattered over the surface throughout the greater part of the area covered by this type or are generally present at shallow depths.

The Roselawn stony sandy loam occurs in the southeastern part of the county, comprising an aggregate area of about 90 square miles, although small tracts of a few other types are included in the area as shown on the map.

The topography on the whole is rolling or choppy and is characterized by irregular ridges, knolls, and broad swells, with gentle to moderately steep slopes, inclosing flat-bottomed filled-in valleys and basins. The local range in relief is from about 100 to 200 feet. The elevation of most of this country is probably from 1,400 to 1,600 feet above sea level.

The forest growth is characterized by hemlock, hard maple, and yellow birch as the dominant species, with a small proportion of white pine. Probably hardwoods predominate slightly over conifers. There is or was a dense stand of trees, so that a very large number of stumps per acre are left on cut-over land. The growth following logging and fires is principally aspen or "popple," with some large-toothed aspen and white birch on the coarser textured variations.

The crops grown on the few small tracts which have been cleared are clover, potatoes, wheat, oats, corn for silage, and apples. This type, because of defects which may be inferred from the coarse texture and rather pervious structure and because of the rolling or hilly topography, is less favorable for farming, and particularly for the growing of clover and timothy hay, than the heavier and more level land. The necessity of removing stones over much of it also increases the cost of clearing for successful cultivation. The less strongly sloping, finer textured, and less stony areas might be expected to give the best results under present conditions.

PORCUPINE LOAM.

The profile of the virgin soil of the Porcupine loam consists of (1) litter and forest mold, 2 to 3 inches; (2) a dark-colored loam, rich in humus, 2 to 3 inches; (3) a light-grayish or faded-red fine sandy loam or loam, 2 to 4 inches; (4) a layer of reddish loam, stained a brownish color at the top from organic matter, variable in thickness and grading without much change in color into (5) a red mass composed of gravel and bowlders, with interstitial silt, sand, and clay. The profile of the type under cultivation consists of a brownish or slightly reddish loam surface soil to a depth of 6 to 8 inches, a brown loam upper subsoil, and a reddish loam lower subsoil and substratum. Considerable quantities of angular stone fragments are on the surface and throughout the soil section, being rather abundant in the substratum.

The soil is loamy, well aerated, and penetrable, but apparently not excessively droughty. The humus soil is darker and of greater thickness, and the red color is leached out to less depth than in the Roselawn stony sandy loam, which is a lighter type derived largely from crystalline rock material. In degree of perviousness, penetrability,

and inferentially in content of moisture, it is intermediate between the types of the Ontonagon series on the one hand and the Roselawn and Rubicon types on the other. As in the other types, the reddish color of the subsoil and substratum is largely a rock color and not the result of weathering since the material was deposited in its present position.

Within the area represented on the map a number of variations are included, based upon small differences in texture and also upon the size and quantity of stones and gravel either at the surface or at shallow depths. The area east of Rubicon differs from the general run of the type in having a slightly sandier surface soil and a somewhat heavier and more compact lower subsoil.

The Porcupine loam is one of the more extensive types. It includes the greater part of the deeper soil in the Copper Range in the central part of the county and in the Porcupine Mountains, together with smaller areas east of Rubicon and in T. 46 N., R. 40 W., in the southeastern part of the county. In the last-named area the soil differs only slightly from the associated Roselawn stony sandy loam in that it is a little more loamy and darker in color.

The forest growth is of the hardwood type. The dominant species is hard maple, followed by yellow birch and basswood. There are scattered conifers, principally hemlock, and also a few white pines, the proportions of these apparently increasing with increase in sand content and relative perviousness of the soil.

Since there is a dense stand of trees in the virgin forest and a large number of stumps per acre and considerable unmerchantable timber remains after logging, it follows that the cost of clearing recently cut-over land is high.

Only a few fields of this type of soil have been cleared and cultivated, and in fact the greater part of the land is still in virgin forest. The more mountainous areas have a comparatively low value for agriculture at present, either because of excessive stoniness or unfavorable topography. Some of the more desirable areas occur near Rockland and east of Rubicon, where the soil carries only a moderate content of stone and the topography ranges from low and ridgy to strongly rolling.

RUBICON SAND.

The profile of the virgin soil of the Rubicon sand consists of (1) leaf litter, mold, and humus soil, which together have a depth of 2 to 4 inches; (2) a light-grayish, loose sand, nearly free from organic matter, 6 to 12 inches; (3) a brown sand, more or less cemented at the top and in the nature of a hardpan, 6 to 15 inches; (4) a gradational yellowish to light-brownish loose sand, 10 to 20 inches; (5) a geologic substratum of unconsolidated grayish or light-brownish sand or sand and gravel.

The distinguishing peculiarity of the type is the conspicuous development of the gray and brown layers. The coloring agent is largely organic, and it is believed that organic compounds may act as cementing agents, although mineral colloids are not entirely absent. The surface layer of organic soil disappears to a large extent or completely after clearing and cultivation, and the soil has a gray to brownish-gray color. The sand shows acidity in all horizons to depths of 4 or 5 feet or more. As in practically all of the mineral

soils, the surface layer directly after burning or clearing may give a neutral or alkaline reaction.

The structure is loose and pervious both above and below the brown hardpan layer and is uniformly a medium or fine sand in which only minute percentages of silt and clay are found.

The type as mapped is not entirely uniform in texture; both fine and medium classes of sand are included. Also, in places, the material beneath the brown layer is coarse or even gravelly, and in such places the soil is drier and less productive than elsewhere and doubtless would be recognized as a separate type in a more detailed survey. The soil immediately along the shore of Lake Superior also constitutes a variation, as it differs from that farther inland in being composed of more nearly pure quartz sand. Another variation is associated with the Roselawn stony sandy loam in the plains in the southern part of the county. These areas for the most part have a thinner gray subsurface layer, and the brown layer below is not as well developed.

The Rubicon sand occupies 8 per cent of the total area of the county. The largest bodies lie in the eastern part of the county, extending both northward and southward from Rubicon. This is also the dominant type in a narrow strip of country one-forth to 1 mile wide, lying along the shore of Lake Superior. Other small areas are located in the southeastern part of the county.

Most of this land is nearly level, but in places it is marked by low ridges or hummocks, which may be either wind deposits or constructional inequalities of glacial-stream deposits. Natural drainage is ample for agriculture, and in places is excessive because of the extreme perviousness of the sand and rapid percolation of water beyond the reach of plant roots.

The original forest growth over the greater part of the area consisted of white pine as the dominant species. In some places it appears that there was a considerable proportion of Norway pine and jack pine, particularly on the ridges and the soil underlain by the coarser sand or gravel. The forest growth has been almost completely removed, and, as is the case over most of this region, fires have nearly everywhere followed lumbering operations. Much of the land has not yet grown up to trees or shrubs but is covered with a dense growth of bracken, which is extremely troublesome to eradicate when the land is placed under cultivation. In other places there is a scattered growth of stunted scarlet oak, "popple," or aspen, and also large-toothed aspen (*Populus grandidentata* Mich.) and white birch. Grazing is fair on the more open land not covered with ferns. The principal work in clearing operations is the removal of white-pine stumps.

A few small farms have been developed on this type near Rubicon and Ontonagon, and fair crops of potatoes, hay, apples, and common garden vegetables have been produced. June clover was observed in several places on newly cleared land. Probably the best crop yields can be obtained on the finer sand underlain by the harder and thicker brown hardpan. The soil underlain by coarse sand and gravel at shallow depths and that on the ridges or hummocks probably has the least agricultural value, because of deficiency in moisture at critical periods in plant growth.

The prices asked for unimproved land of this type offered for farming purposes have ranged from $10 to $20 an acre (1921).

BERGLAND CLAY.

The profile of the Bergland clay consists of (1) 2 to 3 inches of organic matter in the nature of peat; (2) a dark-grayish silty clay loam 3 to 10 inches; and (3) a grayish or whitish plastic silty clay loam or clay, grading at depths of 20 to 36 inches into reddish clay. Mineralogically the soil is probably the same as the Ontonagon clay, and its differences from that type are probably due to development under poorer drainage conditions.

This type is closely associated with the Ontonagon clay and occurs in the shallow depressions or flatter situations, which are poorly drained but not permanently wet enough to allow the accumulation of any considerable thickness of peat. It is of comparatively small extent.

The agricultural value of the land is small, as it requires drainage for best results, in addition to clearing of trees and stumps, and does not possess a sufficiently high productiveness to compensate for the extra expense. Alsike clover and timothy on this soil may give better results than June clover.

EWEN FINE SANDY LOAM.

The profile of the Ewen fine sandy loam consists of a light-brownish loamy fine sand to fine sandy loam, showing a color tint from organic matter or humus to variable depths of 2 to 8 inches, where it passes into a more pronounced reddish loamy fine sand, loose in structure, extending to depths varying from 2 to 8 feet. A substratum of coarser sand or pervious sand and gravel is everywhere present.

This type is a recent-alluvial soil occurring on the bottoms or flood plains of the larger streams. The surface is level or slightly uneven and hummocky. The land is high enough above stream level to be dry and well aerated ordinarily, but is subject to occasional inundation.

Two other types of recent-alluvial soils were observed during the progress of the survey. One type is composed of a surface layer of silt or very fine sand over a silty clay loam or clay, and the other is composed of more clayey alluvium in the wetter or more poorly drained situations of the bottomland plains.

These different soils are all shown on the soil map by one color, as they are comparatively unimportant both in extent and agricultural value. They are less acid than some of the older soils and very probably possess as much or more fertility, but because of the small width of the bottoms and the winding courses of the streams it is not possible to lay out fields of any considerable size. These lands were in forest, and the clearing operations may be expected to cost as much as on the upland.

Clover, timothy, and redtop could probably be seeded on the uncultivated land for pasture.

ROUGH STONY LAND.

The soil material of the Rough stony land varies considerably in texture and color, and this land is separated from other types

primarily on the basis of the shallow depth of the soil layer over the hard, impenetrable bedrock.

The surface layer of litter and mold and the grayish and brownish layers are present, as in the profile of other types of the older mineral soils of this region. The surface soil is a loam or silt loam, and in general it has a somewhat darker color that extends to a greater depth than in other types. The structure is open and pervious owing to the presence of incorporated stone and gravel. Bedrock of sandstone, conglomerate, and various igneous formations is encountered at depths of 1 foot to 3 feet, and rock outcrops are common. The mineral soil beneath the organic layer and gray layer is either reddish or yellowish, according to the dominance of influence of red sandstone or the igneous rocks, but on much of this land there is nothing more than the organic layer and grayish mineral soil present over bedrock.

This land embraces most of the thinner and stonier soils of the rock knobs of the Copper Range and the Porcupine Mountains.

The tree growth consists of a mixture of hardwoods and conifers. The hardwoods probably predominate, especially on the deeper soil or that which approaches the Porcupine loam type. Mountain maple (*Acer spicatum*) and rock elm are more abundant on this type than elsewhere. Probably the stand is thinner and the individual trees are smaller here than on any other land, but this is due to the scantiness of soil rather than to lack of fertility in what is present. On the thinnest soil on rocky slopes the conifers seem to predominate. White pine, spruce, balsam fir, and arbor vitæ grow here, although the growth is stunted, particularly that of the white pine. Red oak and scarlet oak are found in places on the crests of knobs of the Porcupine Mountains.

On account of the stoniness of the soil and the unfavorable topography, the Rough stony land is unsuitable for field crops or extensive farming. However, small patches here and there are suitable for hay and garden vegetables. The value of this land for forestry purposes is also low, if the existing growth can be used as an indicator. On account of the shallowness of soil and the impenetrable bedrock, which restricts root development, neither rapid growth nor large growth could be expected.

PEAT AND MUCK.

The organic soils have the composition and properties universally peculiar to this class of soils, i. e., they are composed of or contain very high percentages of plant matter in various stages of chemical change, ranging from black and finely divided to brown and coarsely fibrous; absorb and retain high percentages of water; have a low volume weight; high specific heat; and are generally low or deficient in content of potash.

A number of types, based on the thickness of the organic accumulations, degree of decomposition, content of mineral matter, and nature of the substrata, could be separated in this county. The organic accumulation varies in depth from a few inches to 10 feet or more, and the substrata consist variously of sand, sand and gravel, sandy clay, and compact clay. Marl, which is not uncommonly found underlying this class of soil in the southern peninsula, was not observed here, but since the observations were not in detail no unqualified statement that it is absent is ventured. The swamp soil

in the few places examined was found to be rather coarse in texture and derived in large part from the foliage and wood of the trees and shrubs growing upon it, at least in the surface layer. However, there are small bodies of Peat and Muck in open bogs or marshes in which the organic matter consists mainly of the stems and a tough mat of the roots of sedges and other herbaceous aquatic vegetation, which has undergone but little chemical change.

The aggregate acreage of Peat and Muck is possibly near 25,000 to 30,000 acres, according to an estimate based on the amount of swamp land shown on the United States Land Office survey plats for this region. Only the larger areas are shown on the accompanying soil map, the total area mapped reaching 18,176 acres.

The Peat and Muck deposits occur mainly in the southern half of the county, in separate bodies having no drainage outlets, or in narrow elongated strips in constructional valleys through which definite drainage channels can be traced. Some of the larger bodies apparently represent former lakes filled by vegetation; others are simply accumulations on the flatter and more poorly drained land which may be only slightly depressed below the surrounding country.

The forest growth in the drier swamps is chiefly arbor vitæ, white spruce, fir, and in a few places scattered white pine; in the wetter or more permanently saturated parts black spruce and tamarack may predominate, along with willow and several species of shrubs. On deposits which represent an earlier stage in the accumulation of Peat, the plant remains consist mainly of sedges and herbaceous aquatic plants.

The organic soils in this area have very little value for agriculture, as the cost of reclamation, which involves both drainage and the removal of a dense tree growth, are excessive under present economic conditions. In this latitude, particularly, it is probable that cultivated plants would be more susceptible to damage from frost on these depressed areas than on the higher lying mineral soils.

In places where the tress and shrubs have been destroyed by fire, and in natural marshes, there is a dense growth of sedges and a few grasses which have some value for hay. In a few places these are cut for hay, but because of the soft, boggy nature of most of this land the mowing must be done by hand.

COASTAL BEACH.

Coastal beach in this county comprises loose sand lying directly along the shore of Lake Superior. This sand has been deposited by waves and has been shifted about by wind. It occupies only a very narrow strip of beach land, is more or less barren, and has practically no agricultural inportance.

SUMMARY.

Ontonagon County is situated in the northwestern part of the northern peninsula of Michigan.

The topographic features consist of level plains, representing the beds of old glacial lakes; a hilly division in the southeastern part of the county, comprising about 100 square miles; a narrow range of knobs in the central part of the county; and the Porcupine Mountains

in the northwestern part. The lake-bed plains comprise the greater part of the county.

The elevations above sea level range from the level of Lake Superior approximately 600 feet, to about 1,600 feet in the southeastern part of the county. The highest knob in the Porcupine Mountains reaches an elevation of a little more than 2,000 feet.

Throughout the greater part of the county the drainage is good. Swampy and poorly drained land comprises less than 5 per cent of the total area.

All of the larger streams and most of the creeks and branches are perennial. Wholesome and abundant supplies of water can be obtained from wells at comparatively shallow depths.

The county was originally densely forested with both hardwoods and conifers, and a few great tracts of virgin forest still remain. Most of the unimproved land is occupied by stumps and the débris from lumbering or is occupied by a dense cover of second-growth aspen.

The population is 12,428, according to the census of 1920. The county is served by four railway lines, and the principal towns are connected by graded and macadamized highways.

Distance to markets and cost of transportation have a retarding effect on agricultural development at present. Most of the farm products are sold locally.

The climate is cold-temperate, with a normal precipitation (including melted snow) of about 32 inches. The snowfall sometimes exceeds 100 inches. The winters are long and the summers correspondingly short. The growing season ranges from as much as 150 days on the shore of Lake Superior to 80 or 90 days on the high table-lands in the central and southern part of the county. Light frosts damaging to tender vegetation may occur even in July and August.

Farming began in the county as early as 1857, but agricultural development has been slow, and at present only about 3 per cent of the entire land area is in farm crops.

The principal crops grown, in order of their acreage, are hay, oats, wheat, potatoes, barley, field peas, and rye. A number of fruits and vegetables have been grown with some degree of success. On account of the shortness of the growing season and the danger of damage from frost even during the summer, the number of crops and the yields are smaller than in the southern part of the State. Clover (red and alsike) and timothy hay is the most dependable and valuable crop.

Dairy farming in conjunction with the growing of hay and small grain will probably prove to be the most successful type of agriculture in this region.

One of the chief factors retarding the agricultural development is the cost of clearing land.

The virgin soils in general are characterized by a suface layer of organic matter but little decomposed or humified; a grayish or ash-colored surface soil, underlain by a brownish layer which may be in places slightly cemented into a hardpan. The county possesses a wide textural range in soils, including clay, silt loam, loam, sand, and stony types. Most of the soils are fertile while new and are productive within the limitations imposed by climate. The clay and silt loam types may be expected to be more durable than the sands.

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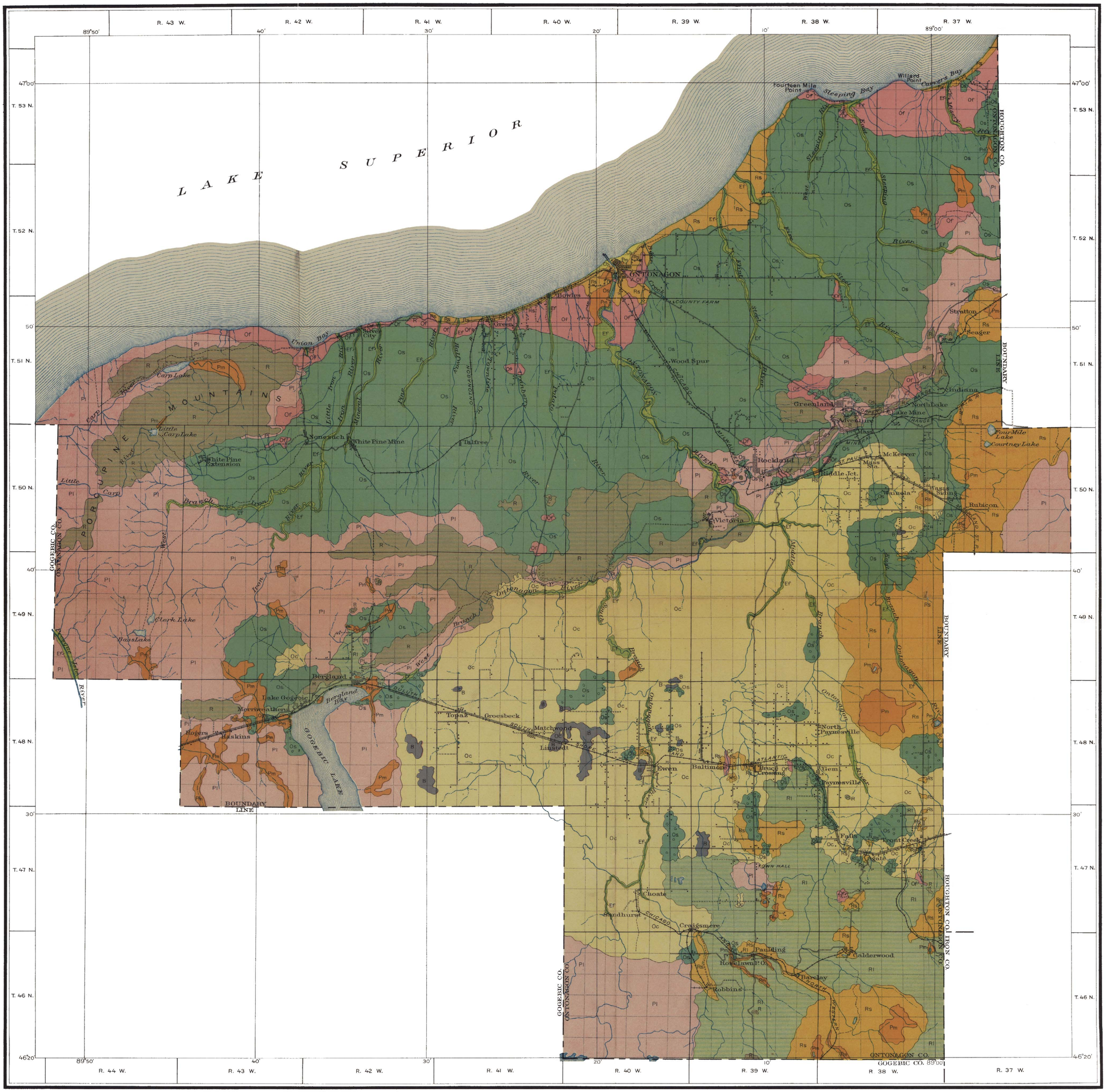
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
IN COOPERATION WITH THE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

SOIL MAP
RECONNAISSANCE SURVEY

MICHIGAN
ONTONAGON COUNTY SHEET



LEGEND

Bergland clay (B)	Porcupine loam (Pl)
Ewen fine sandy loam (Ef)	Roselawn stony sandy loam (Rl)
Ontonagon fine sandy loam (Of)	Rubicon sand (Rs)
Ontonagon silt loam (Os)	Coastal beach (Cb)
Stony phase (Os)	Peat and Muck (Pm)
Ontonagon clay (Oc)	Rough stony land (R)

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines (State, County)
- Boundary lines (Land Grant, City or Village)
- Boundary lines (Civil Township, Reservation)
- U.S. township and section lines

DRAINAGE
(Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Soils surveyed by J. O. Veatch, in charge, and James Tyson of the Michigan Agricultural Experiment Station and W. D. Lee of the U. S. Department of Agriculture.

Scale 1 inch = 3 miles

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Field Operations
Bureau of Soils
1921